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Third edition
2013-03-01

Acoustics — Rating of sound insulation in buildings and of building elements —

Part 1: Airborne sound insulation

Acoustique — Évaluation de l'isolement acoustique des immeubles et des éléments de construction —

Partie 1: Isolement aux bruits aériens

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 717-1 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 2, *Building acoustics*.

This third edition cancels and replaces the second edition (ISO 717-1:1996), which has been technically revised. It also incorporates the Amendment ISO 717-1:1996/Amd. 1:2006.

The purpose of this revised version is to:

— allow weighting steps of 0,1 dB to be used for expression of uncertainty;

— update references.

ISO 717 consists of the following parts, under the general title *Acoustics — Rating of sound insulation in buildings and of building elements*:

— *Part 1: Airborne sound insulation*

— *Part 2: Impact sound insulation*

Introduction

Methods of measurement of airborne sound insulation of building elements and in buildings have been standardized e.g. in ISO 10140-2, ISO 140-4, and ISO 140-5. The purpose of this part of ISO 717 is to standardize a method whereby the frequency-dependent values of airborne sound insulation can be converted into a single number characterizing the acoustical performance.

References to standards which provide data for single-number evaluation are meant to be examples and therefore are not complete.

Acoustics — Rating of sound insulation in buildings and of building elements —

Part 1: Airborne sound insulation

1 Scope

This part of ISO 717:

a) defines single-number quantities for airborne sound insulation in buildings and of building elements such as walls, floors, doors, and windows;

b) takes into consideration the different sound level spectra of various noise sources such as noise sources inside a building and traffic outside a building;

c) gives rules for determining these quantities from the results of measurements carried out in one-third-octave or octave bands in accordance with ISO 10140-2, ISO 140-4, and ISO 140-5.

The single-number quantities in accordance with this part of ISO 717 are intended for rating airborne sound insulation and for simplifying the formulation of acoustical requirements in building codes. An additional single-number evaluation in steps of 0,1 dB is indicated for the expression of uncertainty (except for spectrum adaptation terms). The required numerical values of the single-number quantities are specified according to varying needs. The single-number quantities are based on results of measurements in one-third-octave bands or octave bands.

For laboratory measurements made in accordance with ISO 10140, single-number quantities should be calculated using one-third-octave bands only.

The rating of results of measurements carried out over an enlarged frequency range is dealt with in Annex B.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 140-4:1998, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 4: Field measurements of airborne sound insulation between rooms*

ISO 140-5:1998, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 5: Field measurements of airborne sound insulation of façade elements and façades*

ISO 10140-2:2010, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 2: Measurement of airborne sound insulation*

ISO 10848-2:2006, *Acoustics — Laboratory measurement of the flanking transmission of airborne and impact sound between adjoining rooms — Part 2: Application to light elements when the junction has a small influence*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
single-number quantity for airborne sound insulation rating
value, in decibels, of the reference curve at 500 Hz after shifting it in accordance with the method specified in this part of ISO 717

Note 1 to entry: Terms and symbols for the single-number quantity used depend on the type of measurement. Examples are listed in Table 1 for airborne sound insulation properties of building elements and in Table 2 for airborne sound insulation in buildings. In general, new single-number quantities are derived in a similar way.

3.2
spectrum adaptation term
value, in decibels, to be added to the single-number rating (e.g. R_w) to take account of the characteristics of particular sound spectra

Note 1 to entry: Two sound spectra are defined (in one-third-octave bands and in octave bands) in this part of ISO 717.

Note 2 to entry: Annex A gives information on the purpose of introducing these two spectrum adaptation terms.

Table 1 — Single-number quantities of airborne sound insulation properties of building elements

Derived from one-third-octave band values		Defined in	
Single-number quantity	**Term and symbol**		
Weighted sound reduction index, R_w	Sound reduction index, R	ISO 10140-2:2010	Formula (2)
Weighted normalized flanking level difference, $D_{n,f,w}$	Normalized flanking level difference, $D_{n,f}$	ISO 10848-2:2006	Formula (1)
Weighted element-normalized level difference, $D_{n,e,w}$	Element-normalized level difference, $D_{n,e}$	ISO 10140-2:2010	Formula (5)

Table 2 — Single-number quantities of airborne sound insulation in buildings

Derived from one-third-octave or octave band values		Defined in	
Single-number quantity	**Term and symbol**		
Weighted apparent sound reduction index, R'_w	Apparent sound reduction index, R'	ISO 140-4:1998	Formula (5)
Weighted apparent sound reduction index, $R'_{45°,w}$	Apparent sound reduction index, $R'_{45°}$	ISO 140-5:1998	Formula (3)
Weighted apparent sound reduction index, $R'_{tr,s,w}$	Apparent sound reduction index, $R'_{tr,s}$	ISO 140-5:1998	Formula (4)
Weighted normalized level difference, $D_{n,w}$	Normalized level difference, D_n	ISO 140-4:1998	Formula (3)
Weighted standardized level difference, $D_{nT,w}$	Standardized level difference, D_{nT}	ISO 140-4:1998	Formula (4)
Weighted standardized level difference, $D_{ls,2m,nT,w}$ or $D_{tr,2m,nT,w}$	Standardized level difference, $D_{ls,2m,nT}$ or $D_{tr,2m,nT}$	ISO 140-5:1998	Formula (7)

4 Procedure for evaluating single-number quantities

4.1 General

The values obtained in accordance with ISO 10140-2, ISO 140-4, and ISO 140-5 are compared with reference values (see 4.2) at the frequencies of measurement within the range 100 Hz to 3 150 Hz for one-third-octave bands and 125 Hz to 2 000 Hz for octave bands.

The comparison shall be carried out as specified in 4.4.

Furthermore, two spectrum adaptation terms shall be calculated (see 4.5) based on two typical spectra within the frequency range as quoted above. These two terms may optionally be supplemented by additional spectrum adaptation terms covering (if need be and if measured data are available) a wider frequency range between 50 Hz and 5 000 Hz.

4.2 Reference values

The set of reference values used for comparison with measurement results shall be as given in Table 3. The reference curves are shown in Figure 1 and Figure 2.

Table 3 — Reference values for airborne sound

Frequency	Reference values dB	
Hz	One-third-octave bands	Octave bands
100 125 160	33 36 39	36
200 250 315	42 45 48	45
400 500 630	51 52 53	52
800 1 000 1 250	54 55 56	55
1 600 2 000 2 500	56 56 56	56
3 150	56	

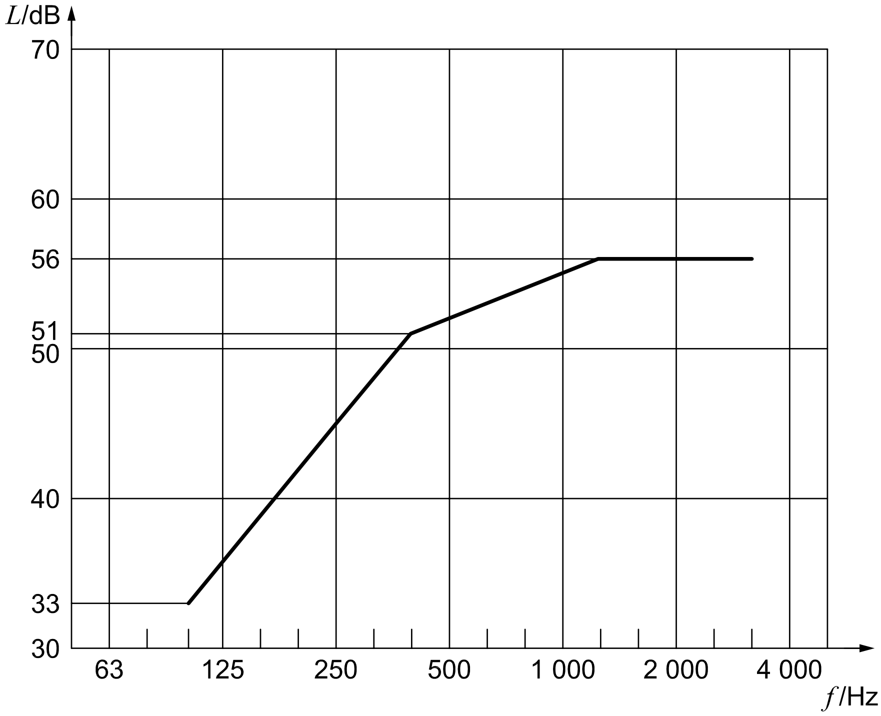
4.3 Sound spectra

The set of sound spectra in one-third-octave bands and octave bands to calculate the spectrum adaptation terms shall be as given in Table 4 and shown in Figure 3 and Figure 4. The spectra are A-weighted and the overall spectrum level is normalized to 0 dB.

4.4 Method of comparison

To evaluate the results of a measurement made in accordance with ISO 10140-2, ISO 140-4, and ISO 140-5 in one-third-octave bands (or octave bands), the measurement data shall be given to one decimal place.[1)] Shift the relevant reference curve in increments of 1 dB (0,1 dB for the expression of uncertainty) towards the measured curve until the sum of unfavourable deviations is as large as possible, but not more than 32,0 dB (measurement in 16 one-third-octave bands) or 10,0 dB (measurement in 5 octave bands).

1) The different parts of ISO 140 state that the results shall be reported “to one decimal place”. However, if the octave or one-third-octave values have been reported with more than one decimal digit, the values shall be reduced to one decimal place before use in the calculation of the single number rating. This is done by taking the value in tenths of a decibel closest to the reported values: XX,XYZ ZZ ... is rounded to XX,X if Y is less than 5 and to XX,X + 0,1 if Y is equal to or greater than 5. Software developers should ensure that this reduction applies to the true input values and not only to the displayed precision (as shown on the screen or printed on paper). Generally this can be implemented by the following sequence of instructions: multiply the (positive) number XX,XYZ ZZ ... by 10 and add 0,5, take the integer part and then divide the result by 10. For further details see ISO 80000-1.[1]

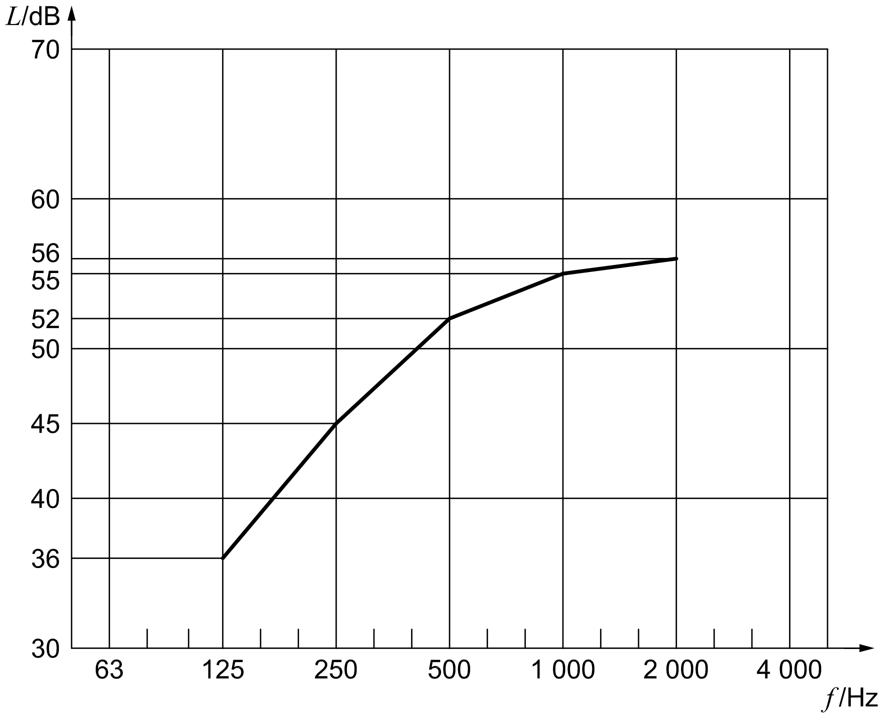


Key

L reference value

f frequency

Figure 1 — Curve of reference values for airborne sound, one-third-octave bands



Key

L reference value

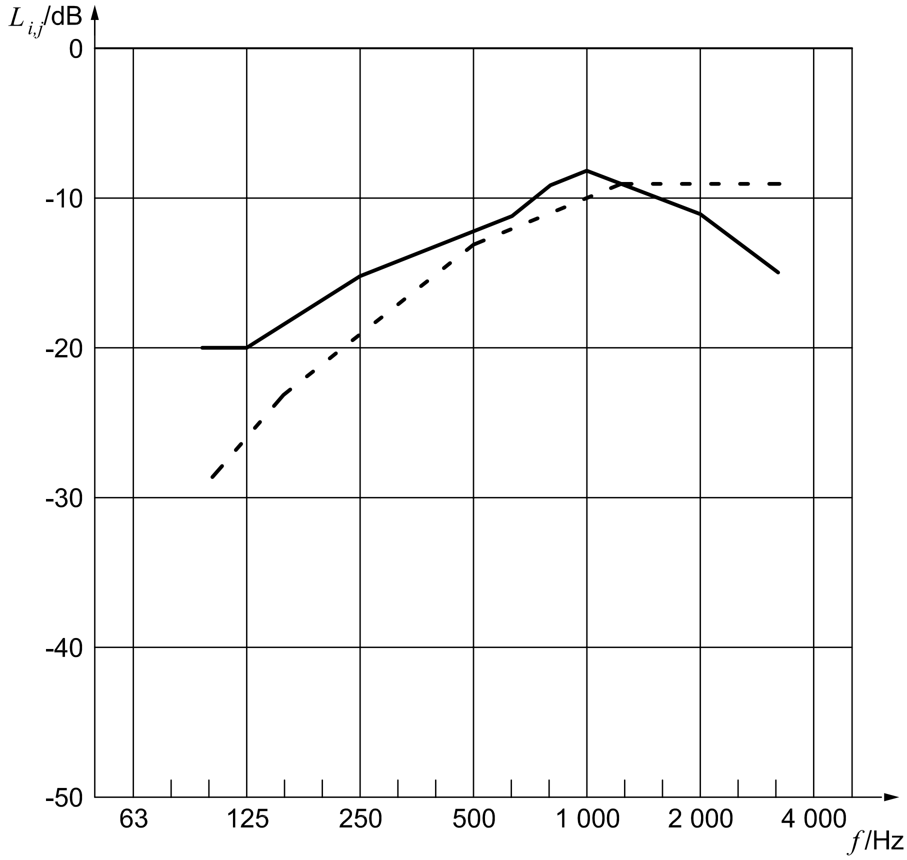
f frequency

Figure 2 — Curve of reference values for airborne sound, octave bands

Table 4 — Sound level spectra to calculate the adaptation terms

Frequency	Sound levels, L_{ij} dB			
Hz	**Spectrum No. 1 to calculate C**		**Spectrum No. 2 to calculate C_{tr}**	
	One-third octave	Octave	One-third octave	Octave
100	−29	−21	−20	−14
125	−26		−20	
160	−23		−18	
200	−21	−14	−16	−10
250	−19		−15	
315	−17		−14	
400	−15	−8	−13	−7
500	−13		−12	
630	−12		−11	
800	−11	−5	−9	−4
1 000	−10		−8	
1 250	−9		−9	
1 600	−9	−4	−10	−6
2 000	−9		−11	
2 500	−9		−13	
3 150	−9		−15	

NOTE All levels are A weighted and the overall spectrum level is normalized to 0 dB.



Key

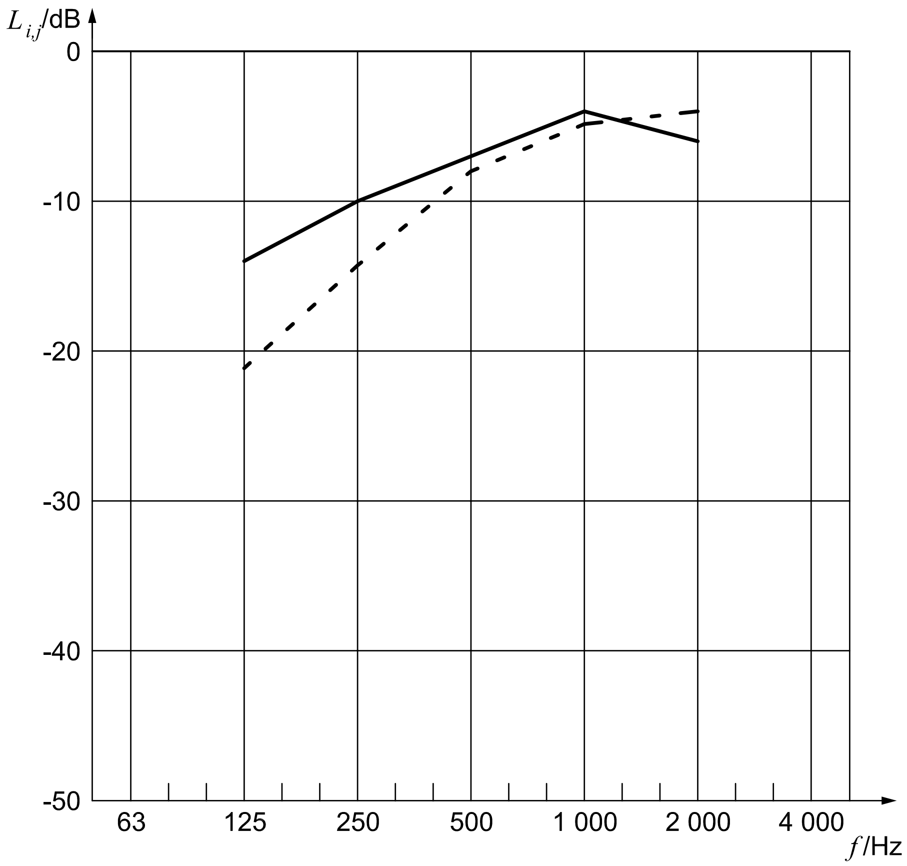
$L_{i,j}$ sound level at the frequency i for the spectrum j

f frequency

- - - - spectrum No. 1 to calculate C

——— spectrum No. 2 to calculate C_{tr}

Figure 3 — Sound level spectra to calculate the spectrum adaptation terms for one-third-octave band values



Key

$L_{i,j}$ sound level at the frequency i for the spectrum j

f frequency

- - - - spectrum No. 1 to calculate C

——— spectrum No. 2 to calculate C_{tr}

Figure 4 — Sound level spectra to calculate the spectrum adaptation terms for octave band measurements

An unfavourable deviation at a particular frequency occurs when the result of measurements is less than the reference value. Only the unfavourable deviations shall be taken into account.

The value, in decibels (or 1/10 dB for the expression of uncertainty), of the reference curve at 500 Hz, after shifting it in accordance with this procedure, is R_w, R'_w, $D_{n,w}$ or $D_{nT,w}$, etc. (see Table 1 and Table 2).

Only use reference values in octave bands for comparison with results of measurements in octave bands in the field.

4.5 Calculation of spectrum adaptation terms

The spectrum adaptation terms, C_j, in decibels, shall be calculated with the sound spectra given in 4.3 from the following equation:

$$C_j = X_{Aj} - X_w \quad (1)$$

where

j is the subscript for the sound spectra Nos. 1 and 2;

X_w is the single-number quantity calculated according to 4.4 from R, R', D_n or D_{nT} values;

X_{Aj} is calculated from

$$X_{Aj} = -10 \lg \sum 10^{(L_{ij} - X_i)/10} \text{ dB} \quad (2)$$

in which

i is the subscript for the one-third-octave bands 100 Hz to 3 150 Hz or the octave bands 125 Hz to 2 000 Hz,

L_{ij} are the levels as given in 4.3 at the frequency i for the spectrum j,

X_i the sound reduction index, R_i, or apparent sound reduction index, R_i', or normalized sound level difference, $D_{n,i}$, or standardized sound level difference, $D_{nT,i}$, at the measuring frequency i, given to one decimal place.

Calculate the quantity, X_{Aj}, with sufficient accuracy and round the result to an integer.2) The resulting spectrum adaptation term is an integer by definition and shall be identified in accordance with the spectrum used, as follows:

C, when calculated with spectrum No. 1 (A-weighted pink noise);

C_{tr}, when calculated with spectrum No. 2 (A-weighted urban traffic noise).

NOTE 1 The spectra of most of the usual prevailing indoor and outdoor noise sources lie in the range of spectra Nos. 1 and 2; the spectrum adaptation terms C and C_{tr} may therefore be used to characterize the sound insulation with respect to many types of noise. Guidelines for the relevant spectrum adaptation terms are given in Annex A.

NOTE 2 Supplementary calculations of the spectrum adaptation terms may also be carried out for the enlarged frequency range (including 50 Hz + 63 Hz + 80 Hz and/or 4 000 Hz + 5 000 Hz one-third-octave bands or 63 Hz and/or 4 000 Hz octave bands). The relevant terms and spectra are given in Annex B. An example of the calculation of the single-number quantity and the adaptation terms is given in Annex C.

5 Statement of results

5.1 General

The appropriate single-number quantity R_w, R_w', $D_{n,w}$ or $D_{nT,w}$ and both adaptation terms shall be given with reference to this part of ISO 717.

2) XX,YZZ Z ... is rounded to XX if Y is less than 5 and to XX + 1 if Y is greater than or equal to 5. For further details, see ISO 80000-1.[1] Software implementers should be aware that calculation of the spectrum adaptation terms involves floating-point calculations that are never exact and may incur rounding errors. In some rare cases, this can lead to a difference of +1 dB or −1 dB in the final result. In order to avoid rounding errors, it is strongly recommended that the highest possible machine accuracy available be used for floating-point representation and mathematical operations.

5.2 Statement of performance of building elements

Calculate the single-number quantity from one-third-octave bands only. State the two spectrum adaptation terms in parentheses after the single-number quantity, separated by a semicolon.

EXAMPLE

$$R_{\mathrm{w}}\left(C;C_{\mathrm{tr}}\right)=41\left(0;-5\right)\ \mathrm{dB}$$

The uncertainty of the weighted single-number quantities may also be stated. In this case, the numbers shall be given to one decimal place.

EXAMPLE

$$R_{\mathrm{w}}=40,9\ \mathrm{dB}\pm 0,8\ \mathrm{dB}$$

Spectrum adaptation terms do not have uncertainty values of their own.

5.3 Statement of requirements and of performance of buildings

Requirements shall be given with the single-number quantity according to 4.2 and 4.4 or be based on the sum of this value and the relevant spectrum adaptation term.

EXAMPLE

$$R'_{\mathrm{w}}+C_{\mathrm{tr}}\geq 45\ \mathrm{dB}$$

(e.g. for façades) or

$$D_{\mathrm{n}T,\mathrm{w}}+C\geq 54\ \mathrm{dB}$$

(e.g. between dwellings).

The acoustic performance of buildings shall be given in the relevant terms according to the requirements (see Annex A).

For field measurements in accordance with ISO 140-4 or ISO 140-5, it shall be stated whether the single-number quantity is calculated from measuring results in one-third-octave bands or octave bands. In general, there can be differences between single-number quantities calculated from one-third-octave or octave band measurements of about ±1 dB.

Annex A
(informative)

Use of spectrum adaptation terms

NOTE The spectrum adaptation terms C and C_{tr} were introduced into ISO 717-1:1996 (which also incorporated ISO 717-3:1982) to take into account different spectra of noise sources (such as pink noise and road traffic noise) and to assess sound insulation curves with very low values in a single frequency band. (The validity of the rating obtained with the reference curve alone is limited for such cases.) The spectrum adaptation term in this sense replaces the 8 dB rule used in ISO 717-1:1982. C and C_{tr} have not been included as one single-number quantity, but have been included as separate numbers. This is to ensure continuity with the reference curve system and to avoid the danger of confusion of different single-number quantities of about the same magnitude. Furthermore, interlaboratory tests have shown that the reproducibility of the single-number quantity based on the reference curve is somewhat better.

A.1 Spectrum adaptation term, C

The spectrum adaptation term C is defined in 4.5 as

$$C = X_{A,1} - X_w \tag{A.1}$$

where

$X_{A,1}$ characterizes the difference between the A-weighted sound levels in the source room and the receiving room, for pink noise (spectrum No.1) in the source room;

X_w is the relevant single-number quantity based on the reference curve.

NOTE In several countries, when using pink noise as a sound source,

$$R_{A,1} = R_w + C \tag{A.2}$$

is used as R_A (the sound reduction index) and

$$D_{nT,A,1} = D_{nT,w} + C \tag{A.3}$$

is used as $D_{nT,A}$ (the standardized level difference).

Generally, C is approximately −1; however, when there is a dip in the sound insulation curve in a single frequency band, C becomes less than −1. When comparing constructions, it can therefore be appropriate to consider both R_w and C.

In setting requirements, it can be appropriate to base these on the sum of X_w and C, as stated in 5.3.

A.2 Spectrum adaptation term, C_{tr}

The spectrum adaptation term C_{tr} is defined in 4.5 as

$$C_{tr} = X_{A,2} - X_w \quad \text{(A.4)}$$

where

$X_{A,2}$ characterizes the difference between the A-weighted levels in the source room (or open air in front of the façade) and in the receiving room, for road traffic noise (spectrum No. 2);

X_w is the relevant single-number quantity based on the reference curve.

NOTE In several countries, when using traffic noise as a source signal,

$$R_{A,2} = R_w + C_{tr}$$

is used instead of $R_{A,tr}$ (the sound reduction index) and

$$D_{nT,A,2} = D_{nT,w} + C_{tr} \quad \text{(A.5)}$$

is used instead of $D_{nT,A,tr}$ (the sound insulation).

Generally, for different makes of windows having the same basic construction, the numerical value of the term C_{tr} will be almost the same; in such cases it may be appropriate to use R_w for rating purposes. However, when comparing very different types of constructions, both R_w and C_{tr} should be considered.

Requirements may be based on the sum of X_w and C_{tr} as stated in 5.2. An estimation of the A-weighted indoor level from the known A-weighted traffic noise level in front of the façade should be based on $X_w + C_{tr}$.

A.3 Application of the spectrum adaption terms to additional types of noise

In Table A.1, a number of different noise sources is attached to the spectrum adaptation terms C and C_{tr}. Table A.1 may be used as a guideline for the application of the spectrum adaptation terms to assess the sound insulation with respect to these noise sources. If the A-weighted spectrum of a certain type of noise is known, it can be compared with the data in Table 4 and Figure 3 and Figure 4 and the relevant adaptation term may be chosen.

Table A.1 — Relevant spectrum adaptation term for different types of noise source

Type of noise source	Relevant spectrum adaptation term
Living activities (talking, music, radio, TV) Children playing Railway traffic at medium and high speed[a] Highway road traffic at >80 km/h[a] Jet aircraft, short distance Factories emitting mainly medium- and high-frequency noise	C (spectrum No. 1)
Urban road traffic Railway traffic at low speeds[a] Aircraft, propeller driven Jet aircraft, large distance Disco music Factories emitting mainly low and medium frequency noise	C_{tr} (spectrum No. 2)

[a] In several European countries, calculation models for highway road traffic noise and railway noise exist, which define octave band levels; these could be used for comparison with spectra Nos. 1 and 2.

Annex B
(informative)

Terms and spectra for an enlarged frequency range

When measurements have been carried out for an enlarged frequency range, additional spectrum adaptation terms may be calculated and stated for this frequency range. The frequency range has to be stated as a subscript to C or C_{tr}.

EXAMPLE 1 $C_{50–3150}$ or $C_{50–5000}$ or $C_{100–5000}$

EXAMPLE 2 $C_{tr,50–3150}$ or $C_{tr,50–5000}$ or $C_{tr,100–5000}$

In the statement of results, these additional adaptation terms may be given as follows:

$$R_w(C;C_{tr};C_{50-3150};C_{tr,50-3150}) = 41\ (0;\ -5;\ -1;\ -4)\ \text{dB} \tag{B.1}$$

The sound spectra in one-third-octave bands and in octave bands for the enlarged frequency range are specified in Table B.1 and shown in Figure B.1 and Figure B.2. The spectra, like those in Table 4, are A weighted and the overall spectrum level is normalized to 0 dB.

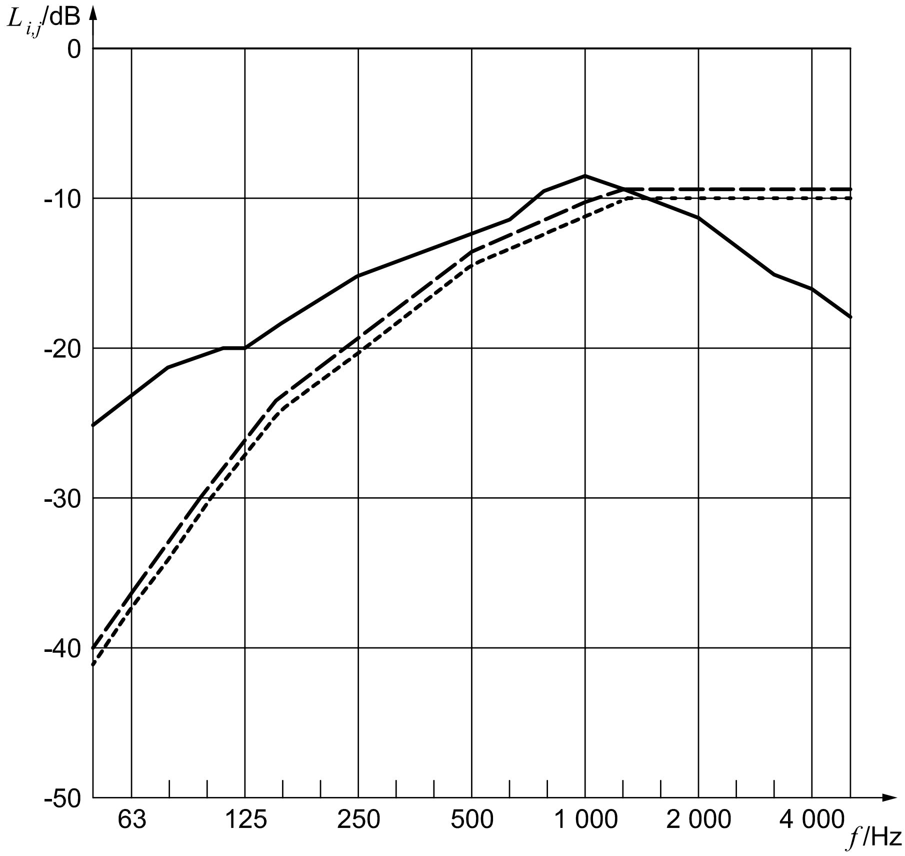
NOTE Because of the normalization to 0 dB, the absolute values for the enlarged frequency ranges 50 Hz to 5 000 Hz and 100 Hz to 5 000 Hz for spectrum No.1 differ by 1 dB from those given for the frequency range 100 Hz to 3 150 Hz in Table 4.

Table B.1 — Sound level spectra to calculate the adaptation terms for enlarged frequency range

Frequency	**Sound levels**, L_{ij}, dB					
Hz	**Spectrum No.1 to calculate**				**Spectrum No.2 to calculate C_{tr} for any frequency range**	
	$C_{50–3150}$		$C_{50–5000}$ and $C_{100–5000}$			
	One-third octave	Octave	One-third octave	Octave	One-third octave	Octave
50 63 80	−40 −36 −33	−31	−41 −37 −34	−32	−25 −23 −21	−18
100 125 160	−29 −26 −23	−21	−30 −27 −24	−22	−20 −20 −18	−14
200 250 315	−21 −19 −17	−14	−22 −20 −18	−15	−16 −15 −14	−10
400 500 630	−15 −13 −12	−8	−16 −14 −13	−9	−13 −12 −11	−7
800 1 000 1 250	−11 −10 −9	−5	−12 −11 −10	−6	−9 −8 −9	−4
NOTE All levels are A weighted and the overall spectrum level is normalized to 0 dB.						

Table B.1 *(continued)*

Frequency	Sound levels, L_{ij}, dB					
Hz	**Spectrum No.1 to calculate**				**Spectrum No.2 to calculate C_{tr} for any frequency range**	
	$C_{50-3150}$		$C_{50-5000}$ and $C_{100-5000}$			
	One-third octave	Octave	One-third octave	Octave	One-third octave	Octave
1 600 2 000 2 500	−9 −9 −9	−4	−10 −10 −10	−5	−10 −11 −13	−6
3 150 4 000 5 000	−9		−10 −10 −10	−5	−15 −16 −18	−11
NOTE All levels are A weighted and the overall spectrum level is normalized to 0 dB.						



Key

$L_{i,j}$ sound level at the frequency i for the spectrum j

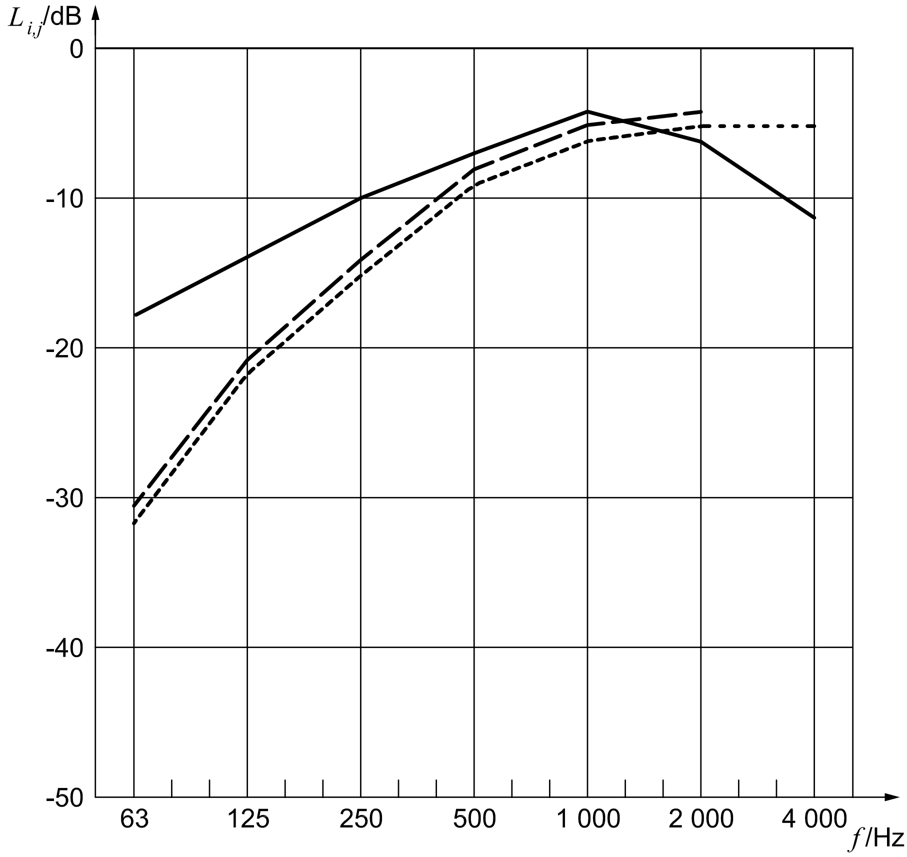
f frequency

- - - - - - spectrum No. 1 to calculate C: 50 Hz to 5 000 Hz and 100 Hz to 5 000 Hz

— — — spectrum No. 1 to calculate C: 50 Hz to 3 150 Hz

——— spectrum No. 2 to calculate C_{tr}

Figure B.1 — Sound level spectra to calculate the spectrum adaptation terms for measurements using one-third octave bands



Key

$L_{i,j}$ sound level at the frequency *i* for the spectrum *j*

f frequency

- - - - - - spectrum No. 1 to calculate *C*: 63 Hz to 4 000 Hz and 125 Hz to 4 000 Hz

— — — spectrum No. 1 to calculate *C*: 63 Hz to 2 000 Hz

——— spectrum No. 2 to calculate C_{tr}

Figure B.2 — Sound level spectra to calculate the spectrum adaption terms for measurements using octave bands

Annex C
(informative)

Examples of the calculation of single-number quantities and spectrum adaptation terms

Table C.1 and Table C.2 show examples of the evaluation of the single-number quantities and spectrum adaptation terms based on the results of the measurement of the sound reduction index of a building element in a laboratory. The results may be stated as

$$R_w(C;C_{tr}) = 30(-2; -3)\ \text{dB} \quad \text{(C.1)}$$

or

$$R_w(C;C_{tr};C_{50-5000};C_{tr,50-5000}) = 30\ (-2; -3; -2; -4)\ \text{dB} \quad \text{(C.2)}$$

Table C.1 — Calculation example: Measurements in the specified frequency range 100 Hz to 3 150 Hz

Frequency	R_i	Reference values shifted by −22 dB	Unfavourable deviation	Spectrum No. 1	$L_{i1} - R_i$	$10^{(L_{i1}-R_i)/10}$	Spectrum No. 2	$L_{i2} - R_i$	$10^{(L_{i2}-R_i)/10}$
Hz	dB	dB	dB	dB	dB	$/10^{-5}$	dB	dB	$/10^{-5}$
100	20,4	11	—	−29	−49,4	1,148…	−20	−40,4	9,120…
125	16,3	14	—	−26	−42,3	5,888…	−20	−36,3	23,442…
160	17,7	17	—	−23	−40,7	8,511…	−18	−35,7	26,915…
200	22,6	20	—	−21	−43,6	4,365…	−16	−38,6	13,803…
250	22,4	23	0,6	−19	−41,4	7,244…	−15	−37,4	18,197…
315	22,7	26	3,3	−17	−39,7	10,715…	−14	−36,7	21,379…
400	24,8	29	4,2	−15	−39,8	10,471…	−13	−37,8	16,595…
500	26,6	30	3,4	−13	−39,6	10,964…	−12	−38,6	13,803…
630	28,0	31	3,0	−12	−40,0	10,000	−11	−39,0	12,589…
800	30,5	32	1,5	−11	−41,5	7,079…	−9	−39,5	11,220…
1 000	31,8	33	1,2	−10	−41,8	6,606…	−8	−39,8	10,471…
1 250	32,5	34	1,5	−9	−41,5	7,079…	−9	−41,5	7,079…
1 600	33,4	34	0,6	−9	−42,4	5,754…	−10	−43,4	4,570…
2 000	33,0	34	1,0	−9	−42,0	6,309…	−11	−44,0	3,981…
2 500	31,0	34	3,0	−9	−40,0	10,000	−13	−44,0	3,981…
3 150	25,5	34	8,5	−9	−34,5	35,481…	−15	−40,5	8,912…
	sum = 31,8 < 32 R_w = 52 − 22 dB = 30 dB			sum = 147,619 9 … × 10^{-5} −10 lg sum = 28,308… C = 28 − 30 dB = −2 dB			sum = 206,063 6 … × 10^{-5} −10 lg sum = 26,859… C_{tr} = 27 −30 dB = −3 dB		

Table C.2 — Calculation example: Measurements in the enlarged frequency range 50 Hz to 5 000 Hz

Frequency	R_i	Reference values shifted by −22 dB	Unfavourable deviation	Spectrum No. 1	$L_{i1} - R_i$	$10^{(L_{i1}-R_i)/10}$	Spectrum No. 2	$L_{i2} - R_i$	$10^{(L_{i2}-R_i)/10}$
Hz	dB	dB	dB	dB	dB	$/10^{-5}$	dB	dB	$/10^{-5}$
50	18,7			−41	−59,7	0,107...	−25	−43,7	4,265...
63	19,2			−37	−56,2	0,239...	−23	−42,2	6,025...
80	20,0			−34	−54,0	0,398...	−21	−41,0	7,943...
100	20,4	11		−30	−50,4	0,912...	−20	−40,4	9,120...
125	16,3	14		−27	−43,3	4,677...	−20	−36,3	23,442...
160	17,7	17		−24	−41,7	6,760...	−18	−35,7	26,915...
200	22,6	20		−22	−44,6	3,467...	−16	−38,6	13,803...
250	22,4	23	0,6	−20	−42,4	5,754...	−15	−37,4	18,197...
315	22,7	26	3,3	−18	−40,7	8,511...	−14	−36,7	21,379...
400	24,8	29	4,2	−16	−40,8	8,317...	−13	−37,8	16,595...
500	26,6	30	3,4	−14	−40,6	8,709...	−12	−38,6	13,803...
630	28,0	31	3,0	−13	−41,0	7,943...	−11	−39,0	12,589...
800	30,5	32	1,5	−12	−42,5	5,623...	−9	−39,5	11,220...
1 000	31,8	33	1,2	−11	−42,8	5,248...	−8	−39,8	10,471...
1 250	32,5	34	1,5	−10	−42,5	5,623...	−9	−41,5	7,079...
1 600	33,4	34	0,6	−10	−43,4	4,570...	−10	−43,4	4,570...
2 000	33,0	34	1,0	−10	−43,0	5,011...	−11	−44,0	3,981...
2 500	31,0	34	3,0	−10	−41,0	7,943...	−13	−44,0	3,981...
3 150	25,5	34	8,5	−10	−35,5	28,183...	−15	−40,5	8,912...
4 000	26,8			−10	−36,8	20,893...	−16	−42,8	5,248...
5 000	29,2			−10	−39,2	12,022...	−18	−47,2	1,905...
	sum = 31,8 < 32 R_w = 52 − 22 dB = 30 dB			sum = 150,919 4... × 10^{-5} −10 lg sum = 28,212... C = 28 − 30 dB = −2 dB			sum = 231,451 8... × 10^{-5} −10 lg sum = 26,355... C_{tr} = 26 − 30 dB = −4 dB		

Bibliography

[1] ISO 80000-1, *Quantities and units — Part 1: General*

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